

**PATENT**

Attorney Docket No.: AMAT/7938/ETCH/SILICON/JB  
Express Mail No.: EV324942792US

**What is Claimed is:**

1. A method of evaluating a processing chamber, comprising:
  - performing a substrate processing operation and a process perturbation operation in a process chamber;
  - collecting optical emission spectroscopy (OES) data and radio frequency (RF) data during the substrate processing operation and the process perturbation operations; and
  - performing a multivariate analysis on the collected OES and RF data from the process chamber.
2. The method of claim 1, wherein the multivariate analysis comprises principle component analysis (PCA).
3. The method of claim 2, further comprising:
  - determining if the OES and/or RF data need to be manipulated;
  - performing the data manipulation; and
  - performing a multivariate analysis on the revised OES and RF data from the chamber.
4. The method of claim 3, wherein steady principle components and transitional principle components are identified for the process chamber by principle component analysis.
5. The method of claim 3, further comprising:
  - using decomposition of an OES and RF data matrix to yield scores of principle components to determine if the OES and/or RF data need to be manipulated.

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6. The method of claim 3, further comprising:  
enhancing the weak signals either by amplifying post perturbation signals, or by selecting a narrower and more sensitive wavelength range or frequency range.
7. The method of claim 1, further comprising:  
using a result of the multivariate analysis to calibrate the process chamber or calibrate another process chamber.
8. The method of claim 1, further comprising:  
using a result of the multivariate analysis to identify a fault in the process chamber or identify a fault in another process chamber.
9. A method of evaluating a process chamber, comprising:  
performing a first substrate processing operation and a first process perturbation operation in a reference chamber;  
collecting optical emission spectroscopy (OES) data and radio frequency (RF) data during the first substrate processing operation and the first process perturbation operation;  
performing a first multivariate analysis on the collected OES and RF data from the reference chamber to produce first multivariate analysis results;  
performing a second substrate processing operation and a second process perturbation operation in a process chamber that is under study, where the first process operation and the second process operation are similar, and the first process perturbation operation and the second process perturbation operation are similar;  
collecting OES data and RF data during the second process operation and the second process perturbation operation;  
performing a second multivariate analysis on the collected OES and RF data from the chamber under study to produce second multivariate analysis results; and

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comparing the second multivariate analysis results from the chamber under study to the first multivariate analysis results from the reference chamber.

10. The method of claim 9 further comprising using a result of the comparing step to calibrate the chamber under study.

11. The method of claim 9, further comprising:

using a result of the comparing step to identify a fault in the chamber under study.

12. The method of claim 9, wherein the first and second multivariate analyses comprise principle component analysis (PCA).

13. The method of claim 9, further comprising:

determining if the OES and/or RF data collected from the reference chamber need to be manipulated;

performing the data manipulation on the data collected from the reference chamber;

performing a multivariate analysis on the revised OES and RF data from the reference chamber; and

manipulating the OES and/or RF data collected from the process chamber that is under study according to the data manipulation scheme developed for the reference chamber.

14. The method of claim 13, wherein steady principle components and transitional principle components are identified for the reference chamber and the chamber under study by principle component analysis.

15. The method of claim 13, wherein comparing the results from the first and second multivariate analyses further comprises performing an inner product of the

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identified principle components for the reference chamber and the chamber under study to generate matching scores.

16. The method of claim 13, further comprising:

using decomposition of OES and RF data matrixes to yield scores for principle components to determine if the OES and/or RF data need to be manipulated.

17. The method of claim 13, further comprising:

enhancing the weak signals either by amplifying post perturbation signals, or by selecting a narrower and more sensitive wavelength range or frequency range.

18. The method of claim 9, further comprising:

comparing the matching scores to a pre-established matching control limit.

19. The method of claim 9, wherein the amount of process parameter perturbation is less than 50%.

20. The method of claim 9, wherein the process chamber is an etching chamber.

21. The method of claim 9, wherein the process chamber is a deposition chamber.

22. The method of claim 9, further comprising:

accessing a library of stored diagnosis information; and

searching the diagnosis information to determine a solution to repair the identified fault.

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23. Apparatus for evaluating a process chamber, comprising:
  - an emission collector operatively coupled to a process chamber to measure emission from a plasma during a substrate processing operation and to produce emission data;
  - an RF power monitoring circuit for monitoring voltage, current and phase of RF signals that are coupled to the process chamber and producing RF data; and
  - a computer processor, coupled to the emission collector, RF power monitoring circuit and the process chamber, for performing a multivariate analysis upon the emission data and the RF data.
24. The apparatus of claim 23, wherein the multivariate analysis comprises principle component analysis (PCA).
25. The apparatus of claim 23, wherein steady principle components and transitional principle components are identified for the process chamber by principle component analysis.
26. The apparatus of claim 23, further comprising:
  - a computer processor, coupled to the emission collector, RF power monitoring circuit, for enhancing the weak signals either by amplifying post perturbation signals, or by selecting a narrower and more sensitive wavelength range or frequency range.
27. The method of claim 1 further comprising using a result of the multivariate analysis to calibrate the process chamber or calibrate another process chamber.
28. The method of claim 1 further comprising using a result of the multivariate analysis to identify a fault in the process chamber or identify a fault in another process chamber.